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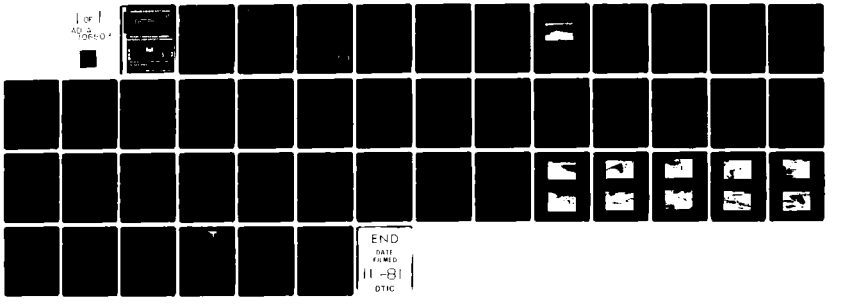

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Lake Tapawingo Dam (MO 20127) Jackson County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report 6. PERFORMING ORG. REPORT NUMBER
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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MISSOURI-KANSAS CITY BASIN

LAKE TAPAWINGO DAM
JACKSON COUNTY, MISSOURI
MO. 20127

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1978

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lake Tapawingo Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Tapawingo dam:

It was prepared under the National Program of Inspection of Non-Federal Dams

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

(1) Spillway will not pass 50 percent of the Probable Maximum Flood.
(2) Overtopping could result in dam failure.
(3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 29 SEP 1978 — Date

APPROVED BY: SIGNED — Colonel, CE, District Engineer — 29 SEP 1978 — Date

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LAKE TAPAWINGO DAM

JACKSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20127

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

UNDER DIRECTION OF

ST. LOUIS DISTRICT CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

AUGUST 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lake Tapawingo Dam
State Located	Missouri
County Located	Jackson County
Stream	Tributary to East Fork Little Blue River
Date of Inspection	22 August 1978

Lake Tapawingo Dam was inspected by a team of engineers from Black & Veatch, Consulting Engineers for the St. Louis District, Corps of Engineers. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam is classified as an intermediate size dam with a high downstream hazard potential. According to the St. Louis District, Corps of Engineers failure would threaten the life and property of approximately 33 families downstream of the dam and would potentially cause appreciable damage to the bridges of two improved roads within the estimated damage zone which extends 5 miles downstream of the dam.

Our inspection and evaluation indicates the spillway does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will not pass either the probable maximum flood or 50 percent of the probable maximum flood without overtopping but will pass 30 percent of the probable maximum flood, which is greater than the estimated 100-year flood.

Deficiencies visually observed by the inspection team were erosion, seepage, voids between riprap, sloughing of a portion of the embankment, erosion of the discharge channel and undercutting of the concrete exit apron, and the presence of excessive brush and small trees on the downstream embankment slope. Seepage and stability analyses required by the guidelines were not available.

There were no observed deficiencies or conditions existing at the time of the inspection which indicated an immediate safety hazard. Future corrective action and regular maintenance will be required to correct or control the described deficiencies. In addition an engineer experienced in the design of earthen dams should be retained by the owner to make detailed seepage and stability analyses of the existing dam. A detailed report discussing each of these deficiencies is attached for submittal to lake owners and to the Governor of Missouri.

D.P. Gupta, PE
Missouri E-17479

E.R. Burton, PE
Missouri E-10137

Harry L. Callahan, Partner
Black & Veatch

OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE TAPAWINGO DAM

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

LIST OF PLATES

LIST OF PHOTOGRAPHS

APPENDIX

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the District Engineer of the St. Louis District, Corps of Engineers, directed that a safety inspection of the Lake Tapawingo Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure located in the valley of a tributary to the East Fork of Little Blue River in central Jackson County, Missouri (Plate 1). A roadway has been constructed across the top of the dam. Topography of the contributing watershed is characterized by rolling hills. The watershed is primarily comprised of residential areas and farmland. Topography in the vicinity of the dam is shown on Plate 2.

(2) There is a spillway located at each abutment of the dam. For purposes of this report the gated spillway will be designated as the service spillway and the ungated spillway as the emergency spillway. The service spillway is located in the east abutment. This spillway has an approach channel with a concrete lined-trench which is 6 feet deep and 6 feet wide. Located just downstream of the bridge over the spillway is a gate in the trench. The lifting device for the gate has been removed, and it appears the gate has not been lifted in some time. This discharge channel is comprised of both a concrete floor on the right of the trench and an earthen bottom on the left.

(3) The emergency spillway is located at the west abutment. This spillway is comprised of two box culverts over which the road was constructed. An approach channel with a concrete floor directs flow to the culverts which discharge to a concrete exit apron. The existing discharge channel has a broken rock and rubble bottom with no side slope protection.

(4) A pipe runs through the embankment to a fish hatchery at the downstream toe of the dam. The pipe is located near the center of the embankment. No other information was available.

(5) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located in central Jackson County, Missouri, as indicated on Plate 1. The lake formed by the dam is shown on the United States Geological Survey 7.5 minute series quadrangle map for Blue Springs, Missouri in Sections 34 and 35 of T49N, R31W.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, the dam and impoundment are in the intermediate size category.

d. Hazard Classification. The hazard classification for this dam is as follows: The Lake Tapawingo Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, and serious damage to homes, extensive agricultural, industrial and commercial facilities, and to important public utilities, main highways or railroads. For the Lake Tapawingo Dam the flood damage zone extends downstream for 5 miles. Within the damage zone are three homes, thirty mobile homes, one fish hatchery, two major road crossings, two minor road crossings and one railroad.

e. Ownership. The dam is owned by Lake Tapawingo Development Company, Route 2 Box 135, Blue Springs, Missouri 64015.

f. Purpose of Dam. The dam forms a 80-acre recreational lake.

g. Design and Construction History. Data relating to the design and construction were not available.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, and evaporation all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 1,350 acres

b. Discharge at Damsite.

(1) Normal discharge at the damsite is through the controlled service spillway. The water level could be lowered 6 feet below normal pool elevation by removing the gate in the 6 by 6 foot spillway trench. With the gate in place, the crest of the service spillway is only 0.7 foot below the uncontrolled emergency spillway. Therefore, the emergency spillway will probably have flow through it several times a year.

(2) Estimated experienced maximum flood at damsite - 1,200 cfs. This estimate based on a resident's account of the water level being within 1/2 foot of the top of the dam during the September 1977 flood.

(3) Estimated combined spillway capacity at maximum pool elevation (Top of dam) - 1,500 cfs.

(4) No estimate of the capacity of the pipe to the fish hatchery was made since no information was available and the pipe was not observed.

c. Elevation (Feet Above M.S.L.).

(1) Top of dam - 844.5 ± (see Plate 3)

(2) Service spillway crest - 839.3 (Gated)

(3) Emergency spillway crest - 840.0

(4) Streambed at centerline of dam - 790 ±

(5) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 4,800 feet ±

e. Storage (Acre-feet).

(1) Top of dam - 1,444 (from 1973 inventory)

(2) Design Surcharge - Not available

f. Reservoir Surface (Acres).

(1) Top of dam - 110

(2) Spillway crest - 80

g. Dam.

(1) Type - earth embankment

(2) Length - 970 feet

(3) Height - 55± feet

(4) Top width - 32 feet

(5) Side Slopes - (see Plate 4)

(6) Zoning - Unknown

(7) Impervious Core - Unknown

(8) Cutoff - Unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel - None.

i. Emergency Spillway.

(1) Type - Chute.

(2) Width of Culvert - 13 feet each, 26 feet total.

(3) Crest Elevation - 840.0 feet m.s.l.

(4) Gates - none

(5) Upstream Channel - Concrete slab with training wall on right.

(6) Downstrean Channel - Broken rock and concrete rubble. No side slope protection.

j. Service Spillway.

(1) Type - Chute.

(2) Length of Weir - 23 feet.

(3) Crest Elevation - 839.3 feet m.s.l.

(4) Gates - Gate located in 6 foot deep concrete trench, but inoperable at time of inspection (see paragraph 1.2a(2)).

(5) Upstream Channel - Concrete lined, 6 foot deep trench with grass channel on both sides.

(6) Downstream Channel - Concrete floor slab on the right and earth bottom on the left. Natural plunge pool at termination of channel.

k. Regulating Outlets - A pipe of unknown size and elevation runs through the embankment to the fish hatchery on the downstram side of the dam. Construction methods and details are not known. Apparently a valve is on the upstream side of the dam. The operating mechanism and type of valve are not known.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data was unavailable.

2.2 CONSTRUCTION

Construction records were unavailable, however the dam was reportedly built circa 1926.

2.3 OPERATION

The maximum recorded loading on the dam is unknown.

2.4 EVALUATION

a. Availability. The only engineering data available pertained to proposed modifications to the existing spillways that have never been implemented.

b. Adequacy. The engineering data available were inadequate to make a detailed assessment of design, construction, and operation. The owner should have an engineer experienced in the design of dams perform detailed seepage and stability analyses.

c. Validity. The engineering data available were insufficient to determine the validity of the design, construction, and operation.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of Lake Tapawingo Dam was made on 22 August 1978. The inspection team included professional engineers with experience in dam design and construction, hydrology - hydraulic engineering, and structural engineering. Specific observations are discussed below. No observations were made of the condition of the upstream face of the dam below the pool elevation at the time of the inspection.

b. Dam. The inspection team observed the following items at the dam. The upstream slope above the water level is very steep. The riprap has been covered with asphalt. Voids were observed between the riprap in several areas but their extent and severity could not be determined due to the asphalt overburden. A crack in the asphalt overlay was observed at the junction of the crest and the upstream slope of the dam, however, it could not be determined if the crack extended deeply into the embankment material. Seepage through the embankment was observed at several locations. The observed seepage did not indicate that piping was occurring. Minor seepage was observed at the junction of the dam and the left natural abutment material. Sloughing of the embankment was observed about 200 feet right of the left abutment. The sloughing was probably the result of erosion near the toe of the dam caused by discharges from the emergency spillway. There were numerous small trees and a heavy stand of weeds on the downstream slope.

c. Appurtenant Structures. The emergency spillway at the left abutment consists of a concrete approach apron leading to a double box culvert at the axis of the dam which discharges to a concrete exit apron. Apparently the apron previously extended several hundred feet but has been undermined and broken to the extent that it presently extends about 30 feet downstream from the axis of the dam. Concrete rubble from this apron currently lines the bottom of the existing rock discharge channel. There is no slope protection on either side of the discharge channel and extensive erosion has occurred. The erosion along the right side extends into the dam embankment material. The discharge channel was apparently constructed with rock fill material. The concrete apron that has been destroyed was reportedly built some years after completion of the dam and prior to that time spillway discharges flowed in the rock channel. The bottom of the spillway approach apron is lined with concrete but weeds and even small trees have grown in the sediment and cracks that are present. A water line crosses the apron just upstream from the culvert and could serve as an obstruction to flow. A dock has been placed immediately outside of the apron and could effectively block the box culvert if broken from its moorings. The concrete box culvert appears in good condition with only minor spalling of the floor slab observed.

The service spillway at the right abutment is similar to the emergency spillway. The approach channel has an earth bottom except for a small concrete trench. There is a concrete training wall on the left with a rock cut serving as the training wall on the right. The approach channel leads to a concrete bridge at the axis of the dam. At the bridge a metal sluice gate and frame had been installed in the trench. No operating equipment

was evident and apparently the gate had not been removed for some time. The discharge channel consisted of the concrete trench, a concrete slab to the right of the trench, and an earthen bottom on the left, (See Plate 5). A rock cut on the right served as a training wall and apparently some earthen material had been placed on the left to keep spillway discharges from flowing on the downstream slope of the dam. The discharge channel led to an overflow section which drops to a natural plunge pool. A water line crosses the approach channel just upstream from the bridge and a dock has been placed immediately outside of the approach channel, each of which could obstruct flows through the bridge. The bridge and piers appears in good condition. No erosion of the service spillway channel was observed.

According to a resident of the community, a pipe runs either through or below the embankment to the fish hatchery on the downstream side of the dam. The pipe is evidently located near the center of the dam where a buoy was observed attached to the operating mechanism. The size, material, and invert elevations, of the pipe are unknown as is the type of valve and the operational procedure.

d. Reservoir Area. No slides or excessive erosion due to wave action were observed along the shore of the reservoir.

e. Downstream Channel. Heavy vegetation along the banks and mild channel slopes typical of streams in the area characterize the channel downstream of the spillways.

3.2 EVALUATION

None of the conditions observed are significant enough to indicate a need for immediate remedial action, however, repairs should be made to the emergency spillway discharge channel as soon as possible. If erosion of the emergency spillway discharge channel along the toe of the dam continues unchecked, a serious potential for failure will develop.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Controlled outlet works exist, but are apparently not used, except to supply water to the fish hatchery. The pool is primarily controlled by rainfall, runoff, evaporation, and capacity of the emergency and service spillways.

4.2 MAINTENANCE OF DAM

Maintenance performed was unknown.

4.3 MAINTENANCE OF OPERATING FACILITIES

Maintenance of operating facilities is unknown.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

Existing seepage, erosion, and sloughing observed on the downstream side of the dam increase the potential for failure and warrant regular monitoring and control.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data pertaining to hydrology and hydraulics were unavailable.

b. Experience Data. The drainage area and lake surface area are developed from USGS Blue Springs Quadrangle Map. The spillway and dam layouts are from surveys made during the inspection and drawings relating to proposed spillway modifications.

c. Visual Observations.

(1) The concrete box culvert of the emergency spillway and the bridge of the service spillway are in good condition. The discharge channel and exit apron of the emergency spillway are badly deteriorated. The discharge channel of the service spillway is in good condition as are the approach channels of each spillway.

(2) The only facilities available that could serve to draw down the pool are the gate in the service spillway which is inoperable and the pipe that goes to the fish hatchery. Manually raising the sluice gate at the service spillway would not appreciably increase the spillway capacity; however, it would lower the pool elevation by about 6 feet to 833.3 and thus increasing the available flood storage. No information is available for the pipe to the hatchery.

(3) A spillway and exit channel are located at each abutment. Spillway discharges from the emergency spillway may endanger the integrity of the dam.

d. Overtopping Potential. The spillway will not pass the probable maximum flood, which is the spillway design flood recommended by the guidelines, without overtopping. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The spillway will pass 30 percent of the probable maximum flood without overtopping. This flood is greater than the 100-year estimated according to the methodology outlined by the USGS in "Technique for Estimating the Magnitude and Frequency of Missouri Floods". According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, a high hazard dam of intermediate size should pass 100 percent of the probable maximum flood. The portion of the estimated peak discharge of the probable maximum flood overtopping the dam would be 12,500 cfs of the total discharge from the reservoir of 14,000 cfs. The estimated duration of overtopping is 5.7 hours. The portion of the estimated peak discharge of 50 percent of the probable maximum flood overtopping the dam would be 4,200 cfs of the total discharge of the reservoir of 5,700 cfs. The estimated duration of overtopping is 3.2 hours. Failure of upstream water impoundments shown on the 1975 revised USGS map would not have a significant impact on the hydrologic or hydraulic analysis.

According to the St. Louis District, Corps of Engineers, the effect from rupture of the dam could extend approximately 5 miles downstream of the dam. There are thirty-three inhabited homes (thirty mobile homes) downstream of the dam which could be severely damaged and lives of the inhabitants could be lost should failure of the dam occur.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which affect the structural stability of this dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design data relating to the structural stability of the dam were found.

c. Operating Records. No operational records exist.

d. Post Construction Changes. Apparently several modifications have been made at the dam including raising of the crest, adding a concrete discharge apron to the emergency spillway, widening the road over the dam, placing asphalt over the riprap, and possibly other unreported items for which no engineering data were available. Engineering data were available for two proposed spillway modifications that have not been implemented. The data was prepared by Clarence Stevens and Marion Clark of Marceline, Missouri and R. J. Spiegel of Kansas City, Missouri and provided by the Lake Tapawingo Development Company and Earl C. Meserve, respectively. Each of the proposed spillway modifications would repair the erosion caused by spillway discharges and provide measures to prevent erosion. These proposals would result in improvement to the existing structural stability of the dam.

e. Seismic Stability. The dam is located in Seismic Zone 1 which is a zone of minor seismic risk. A properly designed and constructed earth dam using sound engineering principles and conservatism should pose no serious stability problems during earthquakes in this zone.

The seismic stability of an earth dam is dependent upon a number of factors: The important factors being embankment and foundation materials and shear strengths; abutment materials, conditions, and strength; embankment zoning; and embankment geometry. Adequate descriptions of embankment design parameters, foundation and abutment conditions, or static stability analyses to assess the seismic stability of this embankment were not available and therefore no inferences will be made regarding the seismic stability.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Several items noted during the visual inspection by the inspection team which should be monitored or controlled are seepage through the embankment, voids between the riprap on the upstream slope, sloughing of the downstream embankment slope, erosion of the discharge channels and undercutting of the concrete exit apron, and an uncontrolled stand of brush and small trees on the downstream embankment slope.

b. Adequacy of Information. Due to the inadequacy of engineering design data, the conclusions in this report were based only on performance history and visual conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Due to the lack of data, detailed seepage and stability analyses comparable in scope to the requirements of Chapter 4 of the Recommended Guidelines should be performed.

c. Urgency. A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 could be accomplished now or delayed until observations of this monitoring program and/or the recommendation of a qualified engineer indicate the necessity of action. If the safety deficiencies listed in paragraph 7.1a are not corrected, they will continue to deteriorate and lead to a serious potential of failure. It is the opinion of the inspection team that repairs should be made to the emergency spillway discharge channel as soon as possible.

d. Seismic Stability. This dam is located in Seismic Zone 1. Because stability analyses are not available, the seismic stability of the dam cannot be assessed.

7.2 REMEDIAL MEASURES

a. Alternatives. The present spillways have capacity to pass 30 percent of the probable maximum flood without overtopping the dam. In order to pass the probable maximum flood as required by the Recommended Guidelines, the spillway sizes and/or height of dam would need to be increased.

b. O&M Maintenance and Procedures. The following O&M maintenance and procedures are recommended:

(1) An engineer experienced in the design and construction of earth dams should be retained as soon as possible to develop procedures to prevent further undermining of the emergency spillway exit apron.

(2) Check the downstream face of the dam periodically for seepage and stability problems. If increased seepage flows are observed or additional sloughing on the downstream embankment slope is noted, the dam should be inspected and the condition evaluated by an engineer experienced in design and construction of earthen dams.

(3) Measures to curtail seepage could be undertaken to minimize water loss.

(4) A regular maintenance program should be initiated to control the growth on downstream slope of the dam.

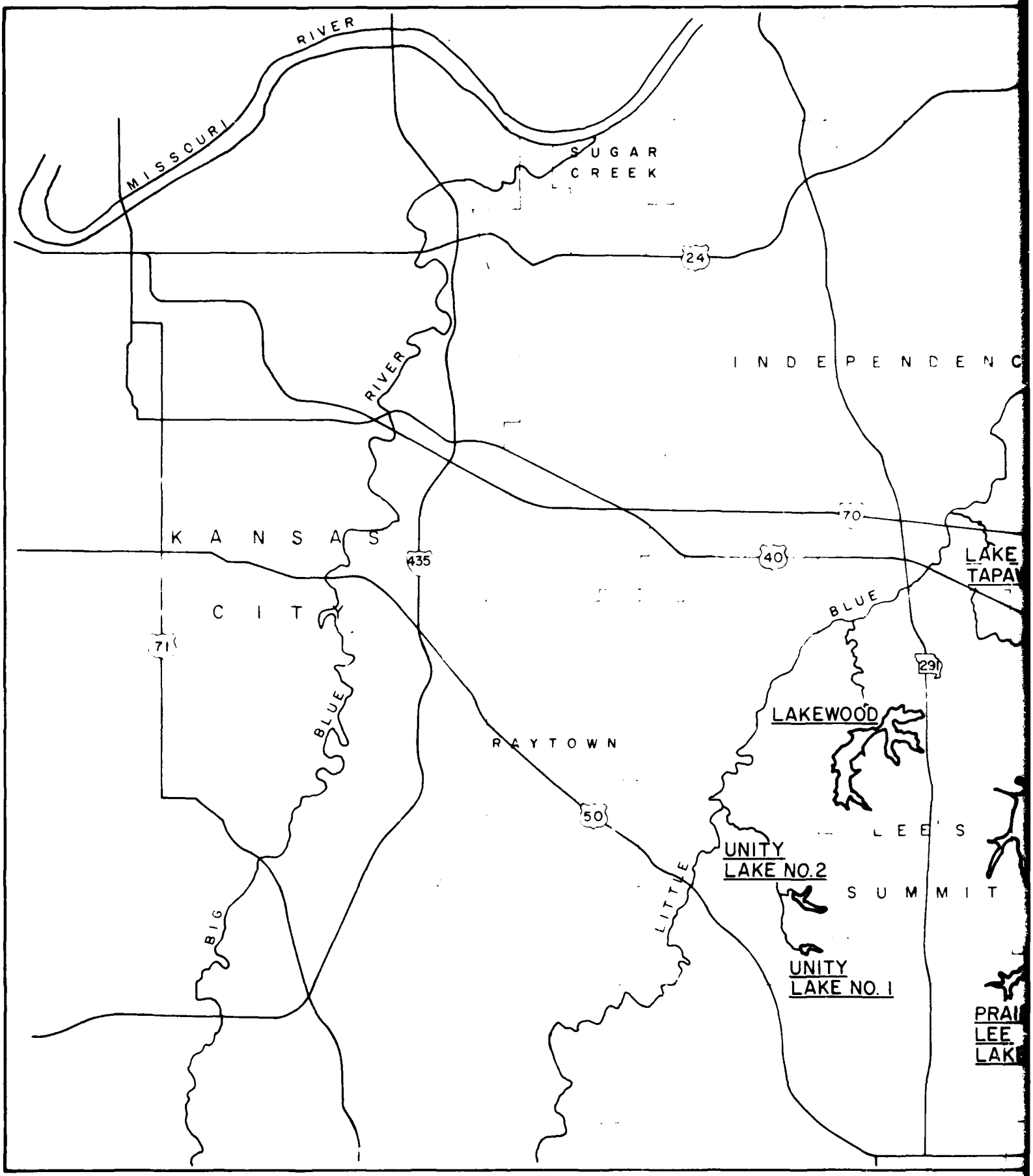
(5) The side slopes of the emergency spillway discharge channel should be protected from erosion especially near the dam embankment to prevent additional erosion and undermining of the dam embankment.

(6) Additional erosion protection should be added on the upstream slope to fill the voids between the existing riprap. This protection is needed to prevent erosion of the embankment material due to wave action.

(7) The sluice gate of the service spillway should be maintained in an operable condition so that the pool level could be lowered to permit maintenance of the upstream face of the dam and possibly to increase flood storage at the reservoir.

(8) The moorings of the docks situated in front of each of the spillways should be inspected regularly to insure that a rapid increase in the reservoir level would not cause the moorings to fail.

(9) A detailed inspection of the dam should be made at least every year by an engineer experienced in design and construction of dams. More frequent inspections may be required if additional deficiencies are observed or the severity of the reported deficiencies increases.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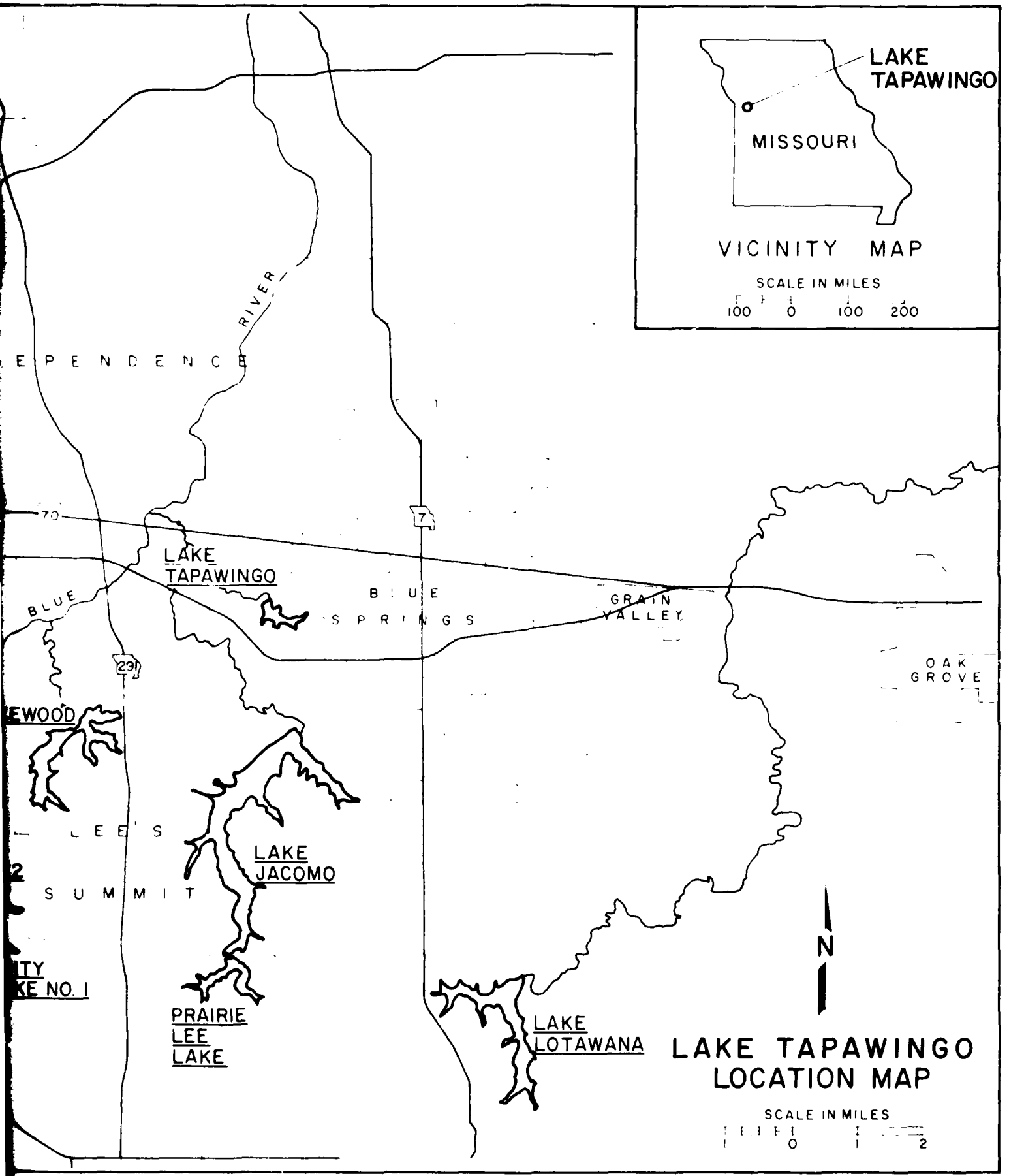
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LOCATION MAP
SCALE IN MILES
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PLATE 1

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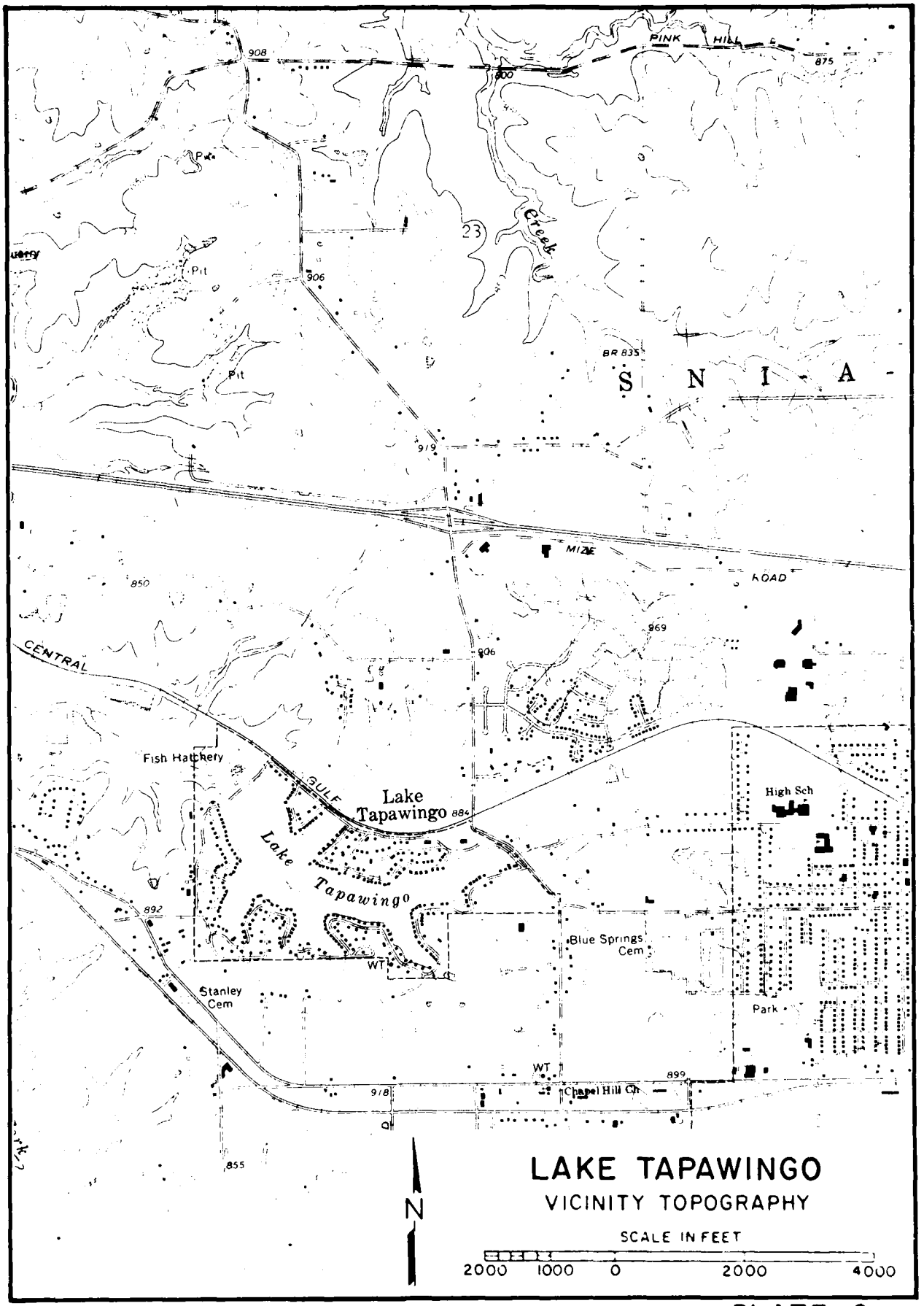
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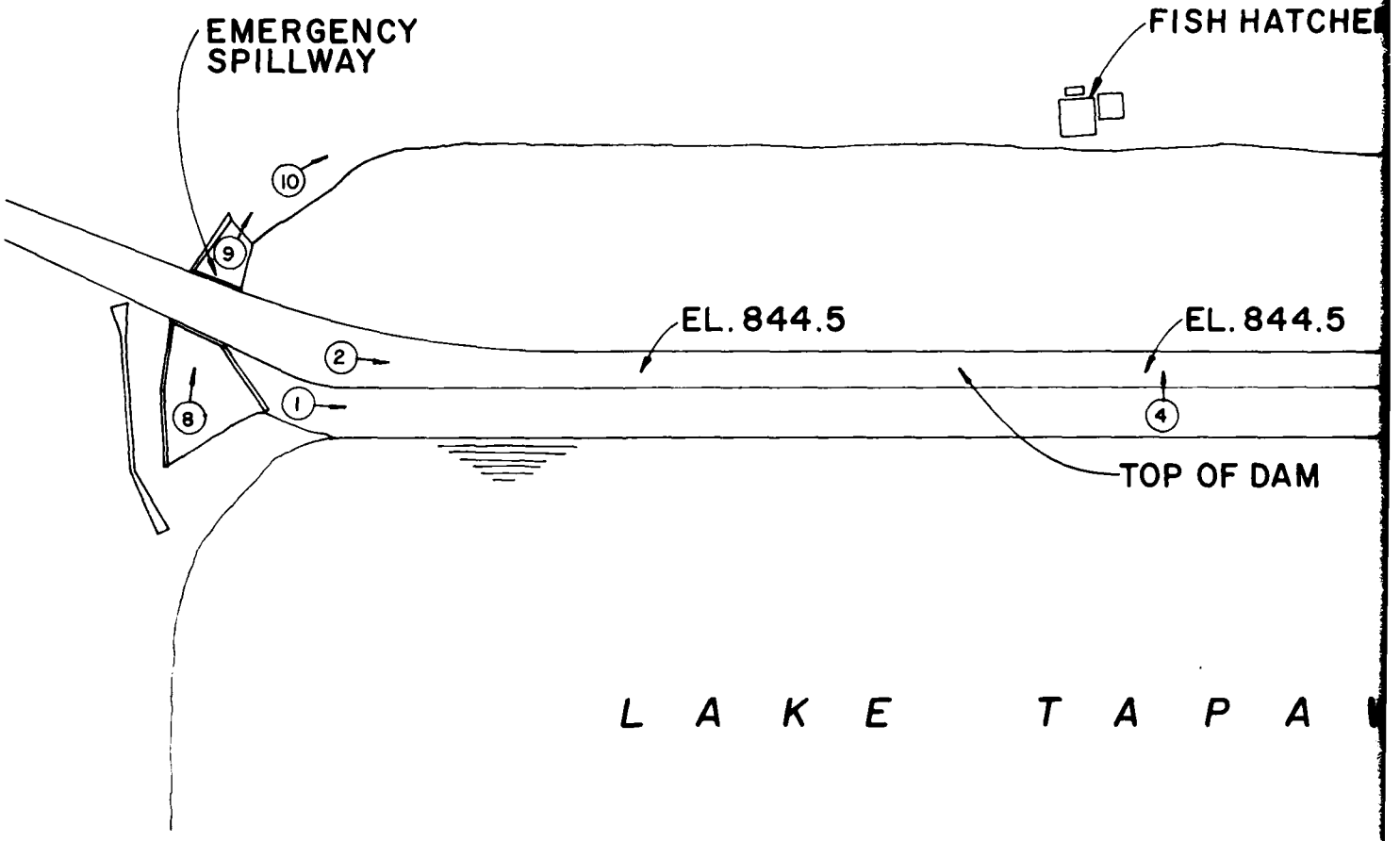
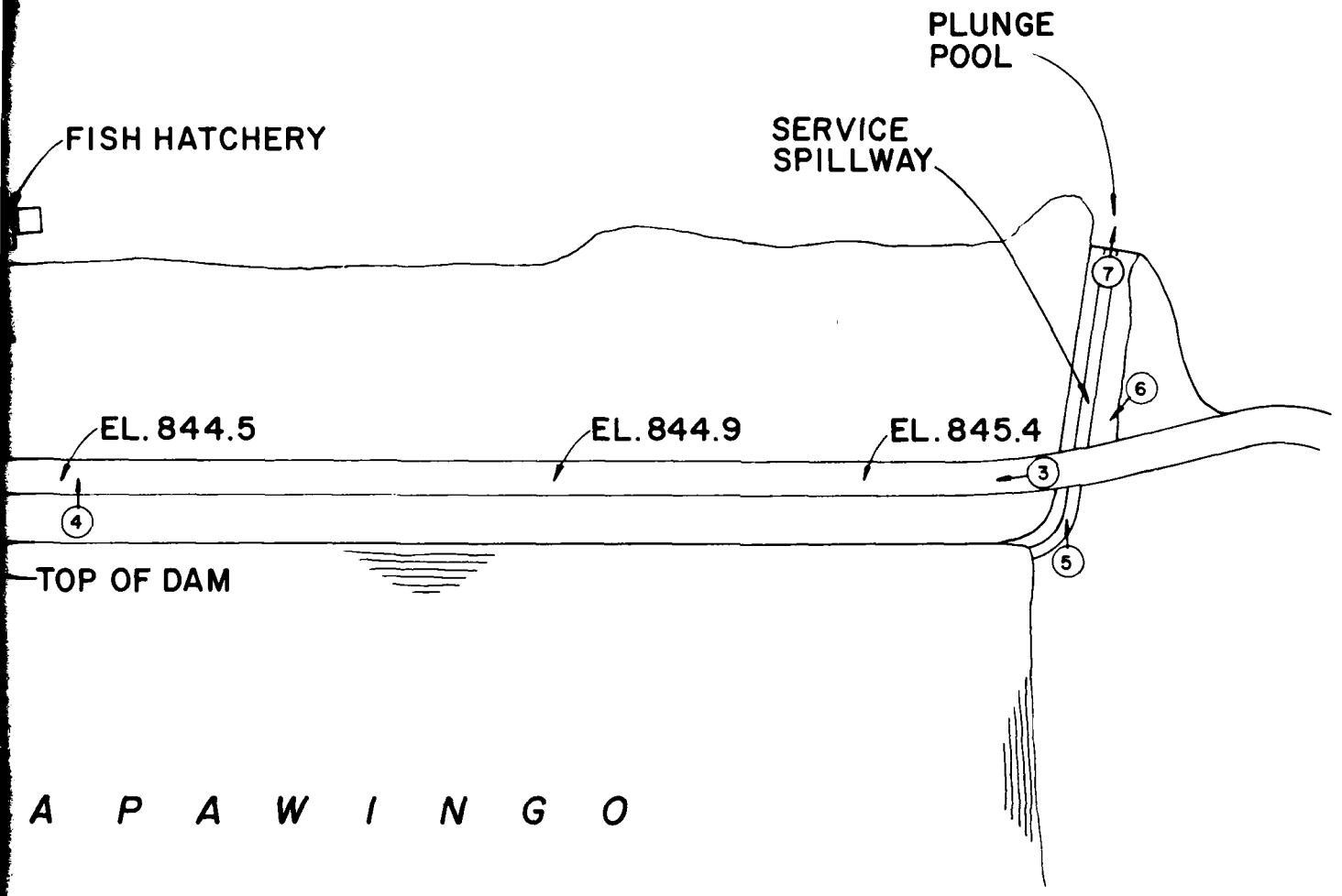
2000 1000 0 2000 4000

PLATE 2


EMERGENCY
SPILLWAY
FISH HATCHE
10
9
2
1
8
EL. 844.5
EL. 844.5
4
TOP OF DAM
L A K E T A P A

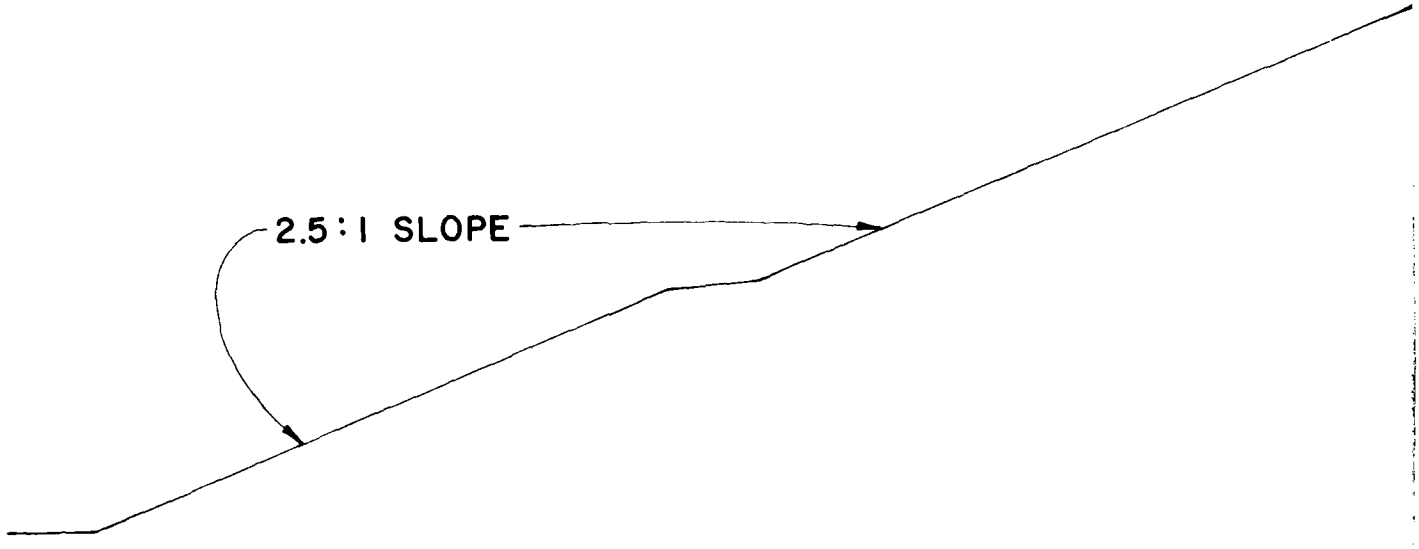


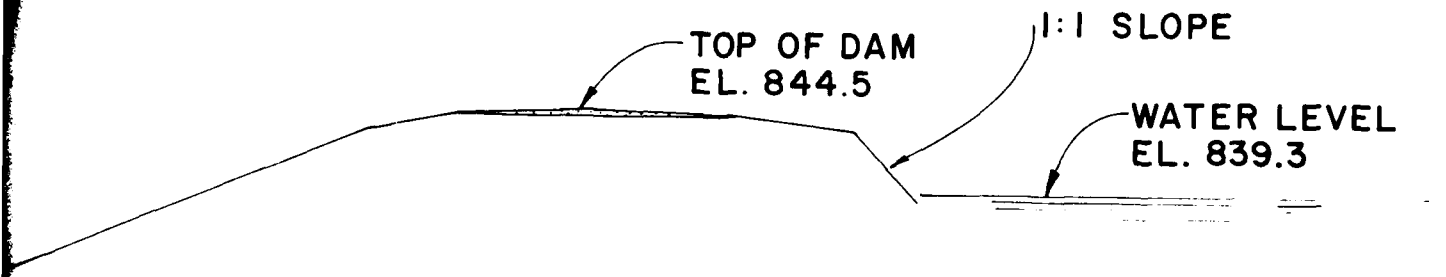
(1)→ NUMBER AND DIRECTION OF PHOTOGRAPH

N

LAKE TAPAWINGO
PLAN

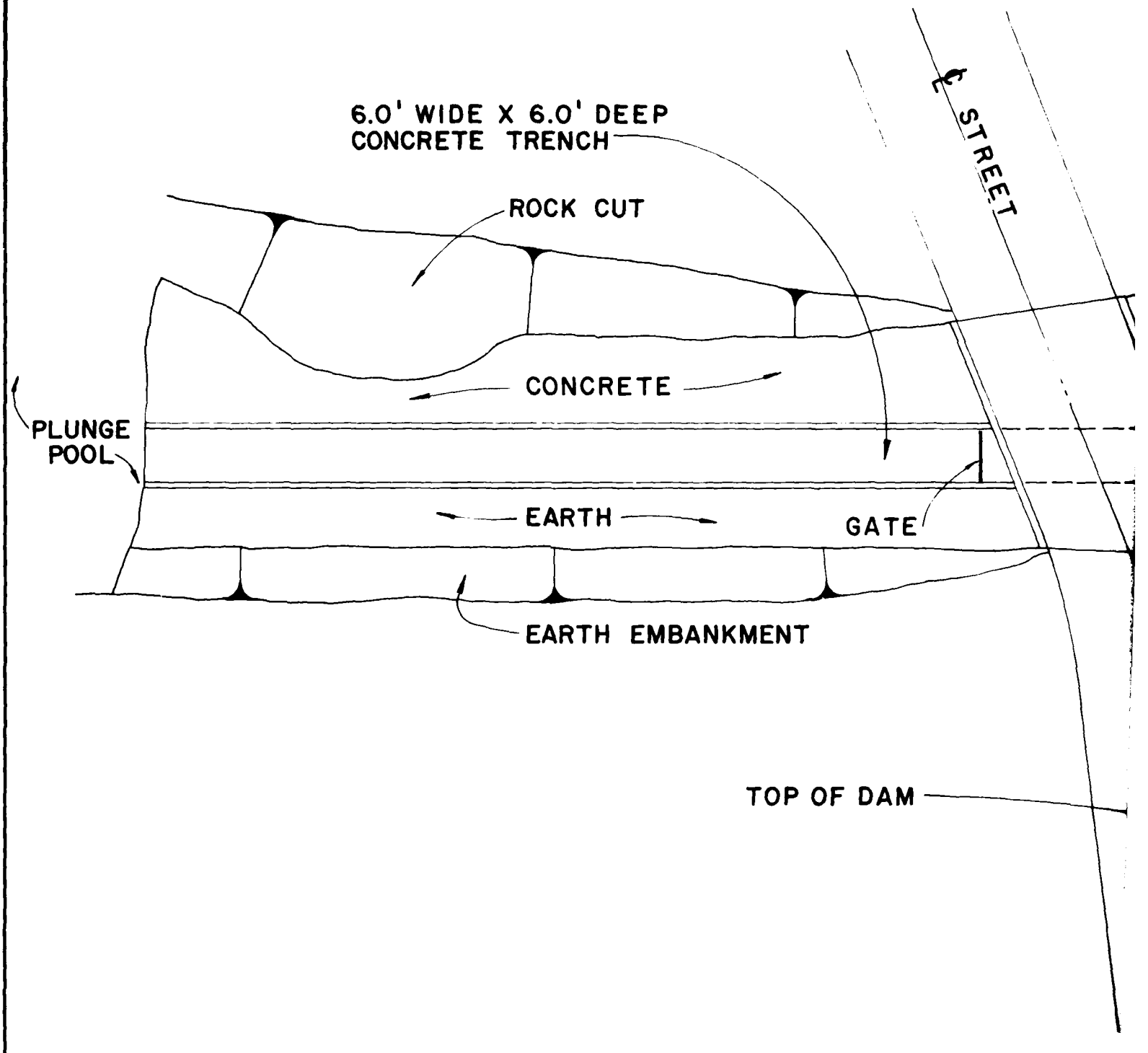
PLATE 3

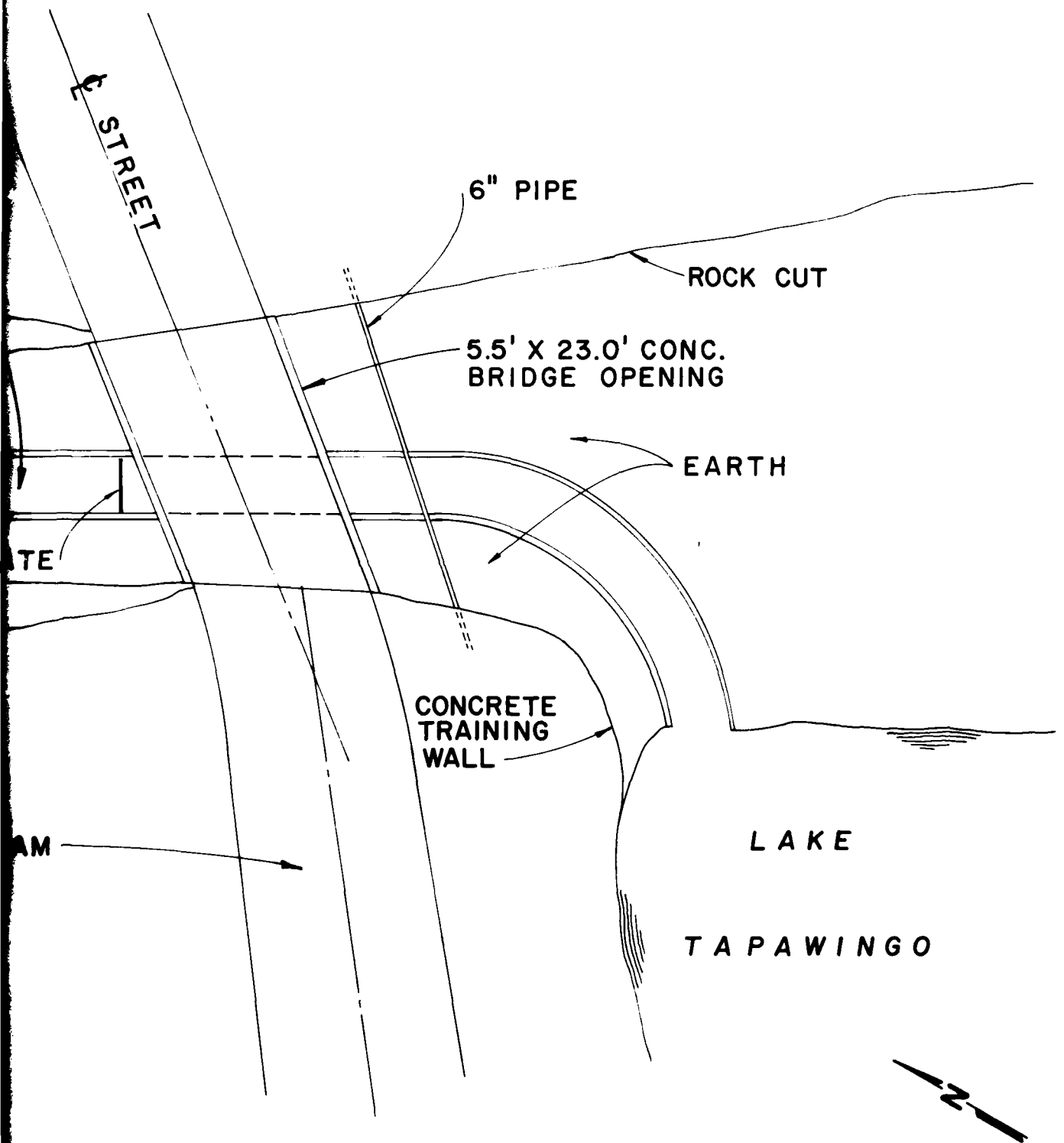

2.5 : 1 SLOPE



LAKE TAPAWINGO
TYPICAL SECTION

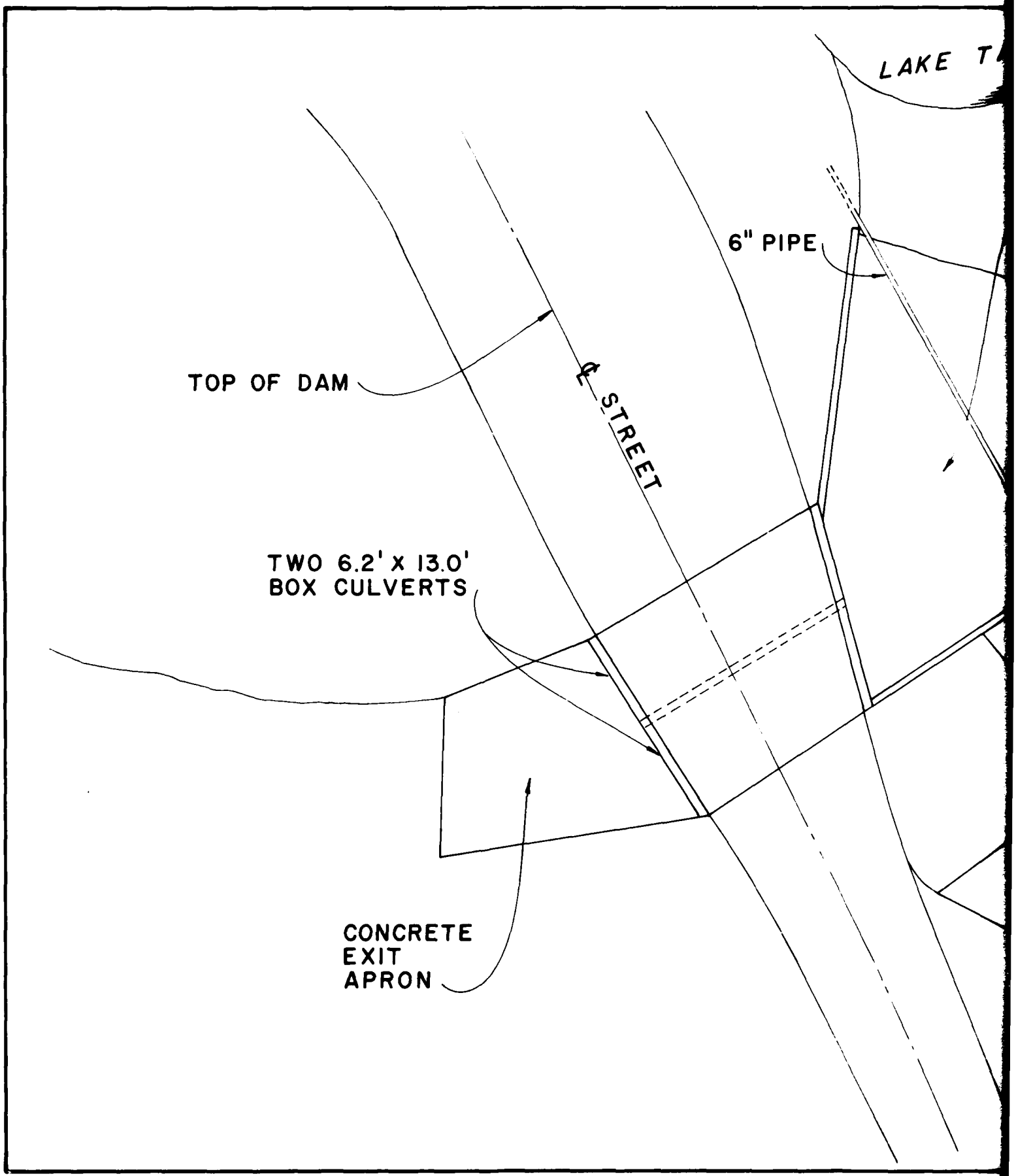
PLATE 4

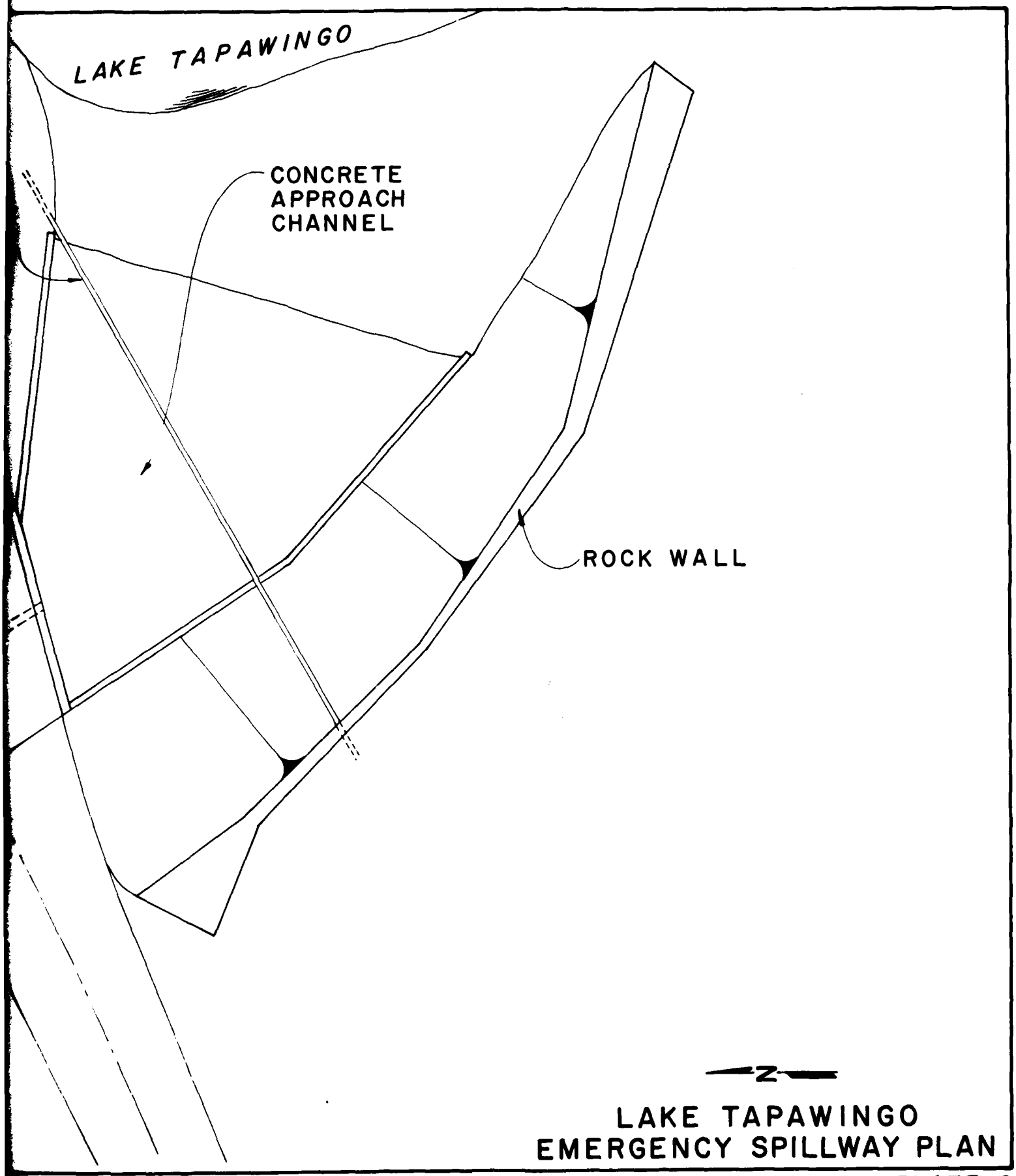

6.0' WIDE X 6.0' DEEP
CONCRETE TRENCH
ROCK CUT
℄ STREET
CONCRETE
PLUNGE
POOL
EARTH
GATE
EARTH EMBANKMENT
TOP OF DAM



LAKE TAPAWINGO
SERVICE SPILLWAY PLAN

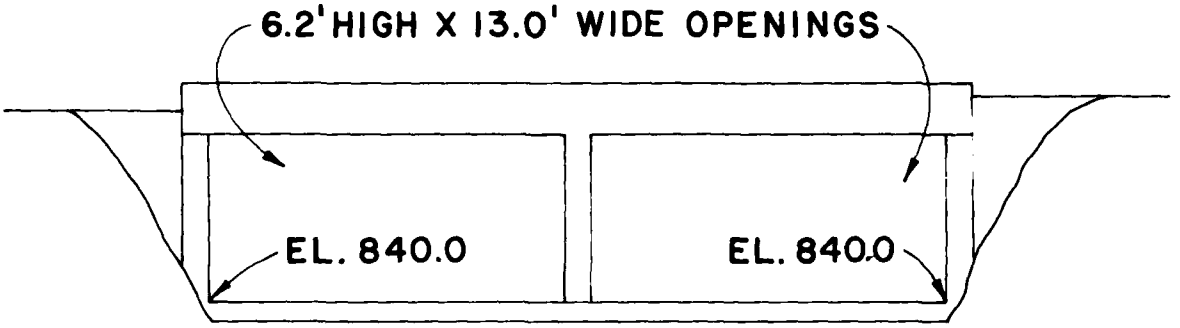
PLATE 5


LAKE T
6" PIPE
TOP OF DAM
℄ STREET
TWO 6.2' X 13.0'
BOX CULVERTS
CONCRETE
EXIT
APRON

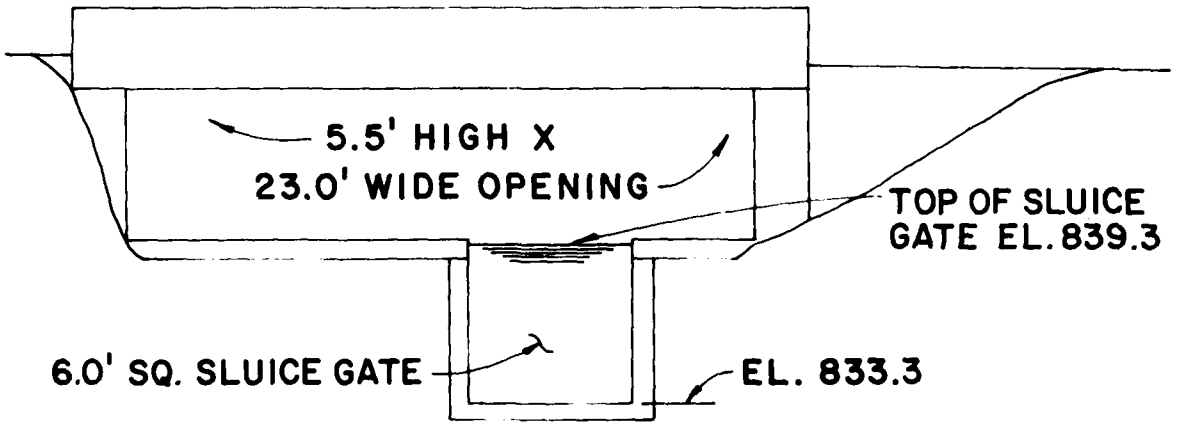


LAKE TAPAWINGO
EMERGENCY SPILLWAY PLAN

PLATE 6



EMERGENCY SPILLWAY



SERVICE SPILLWAY

LAKE TAPAWINGO
SPILLWAY SECTIONS

PLATE 7

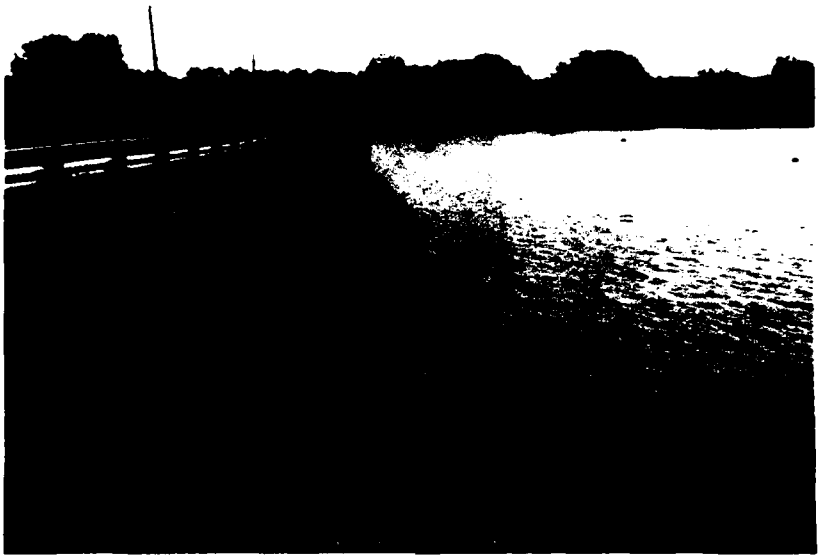


PHOTO 1: UPSTREAM FACE OF DAM (LOOKING EAST)

PHOTO 2: DOWNSTREAM FACE OF DAM (LOOKING EAST)

PHOTO 3: CREST OF DAM (LOOKING WEST)

PHOTO 4: DOWNSTREAM VALLEY

PHOTO 5: SERVICE SPILLWAY APPROACH CHANNEL (LOOKING DOWNSTREAM)

PHOTO 6: SERVICE SPILLWAY SLUICE GATE (LOOKING UPSTREAM)

PHOTO 7: SERVICE SPILLWAY PLUNGE POOL (LOOKING DOWNSTREAM)

PHOTO 8: EMERGENCY SPILLWAY APPROACH CHANNEL (LOOKING DOWNSTREAM)

PHOTO 9: EMERGENCY SPILLWAY EXIT APRON AND DISCHARGE CHANNEL (LOOKING DOWNSTREAM)

PHOTO 10: RUBBLE FROM DETERIORATED EXIT APRON IN DISCHARGE CHANNEL OF EMERGENCY SPILLWAY

APPENDIX A

HYDROLOGIC COMPUTATIONS

HYDROLOGIC COMPUTATIONS

1. The Soil Conservation Service (SCS) dimensionless unit hydrograph and HEC-1 (1) were used to develop the inflow hydrograph (see Plate A-1). Hydrologic inputs are as follows:

a. Twenty-four hour, probable maximum precipitation determined from U.S. Weather Bureau Hydrometeorological Report No. 33:

200 square mile, 24 hour rainfall	- 24.5 inches
10 square mile, 6 hour percent of 24 hour 200 square mile rainfall	- 101%
10 square mile, 12 hour percent of 24 hour 200 square mile rainfall	- 120%
10 square mile, 24 hour percent of 24 hour 200 square mile rainfall	- 130%

b. Drainage area = 1,350 acres.

c. Time of concentration: $Tc = (11.9 \times L^3/H)^{0.385} = 31$ minutes

d. Losses were determined in accordance with SCS methods for determining runoff using a curve number of 86 and antecedent moisture condition III.

2. Spillway release rates are based on the broad-crested weir equation and the orifice equation.

Broad-crested weir equation:

$Q = CLH^{1.5}$ ($C = 2.6$, $L = 23$ feet for the service spillway, $L = 26$ feet for emergency spillway, H is the head on weir).

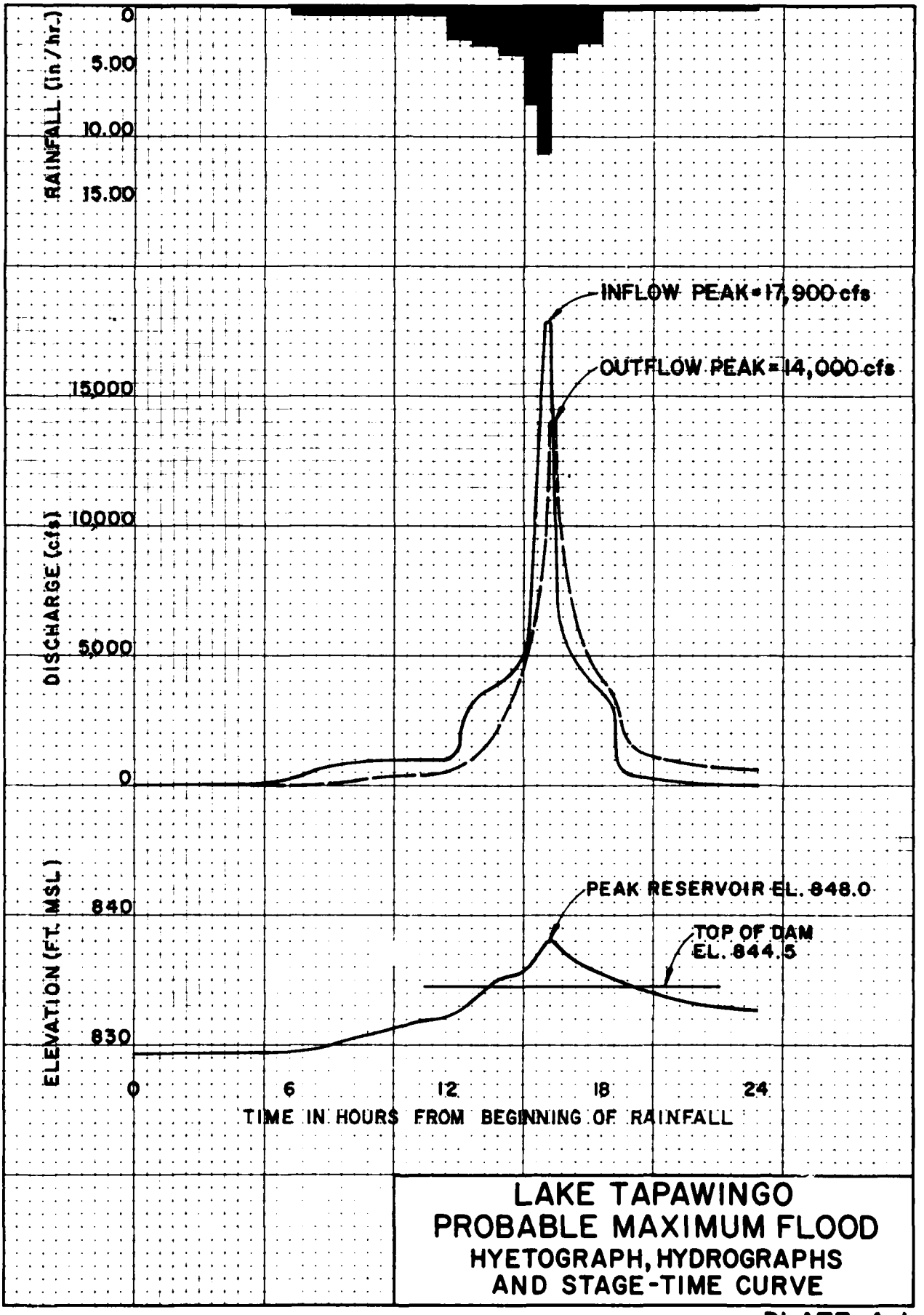
Orifice equation:

$Q = C_dA\ (2gh)^{0.5}$ ($C_d = 0.6$, $A = 126.5$ feet for the service spillway, $A_d = 161.2$ feet for the emergency spillway, h is the head on the orifice)

3. The elevation-storage relationship above normal pool elevation was constructed by planimetering the area enclosed within each contour above normal pool. The storage between two elevations was computed by multiplying the average of the areas at the two elevations by the elevation difference. The summation of these increments below a given elevation is the storage below that level.

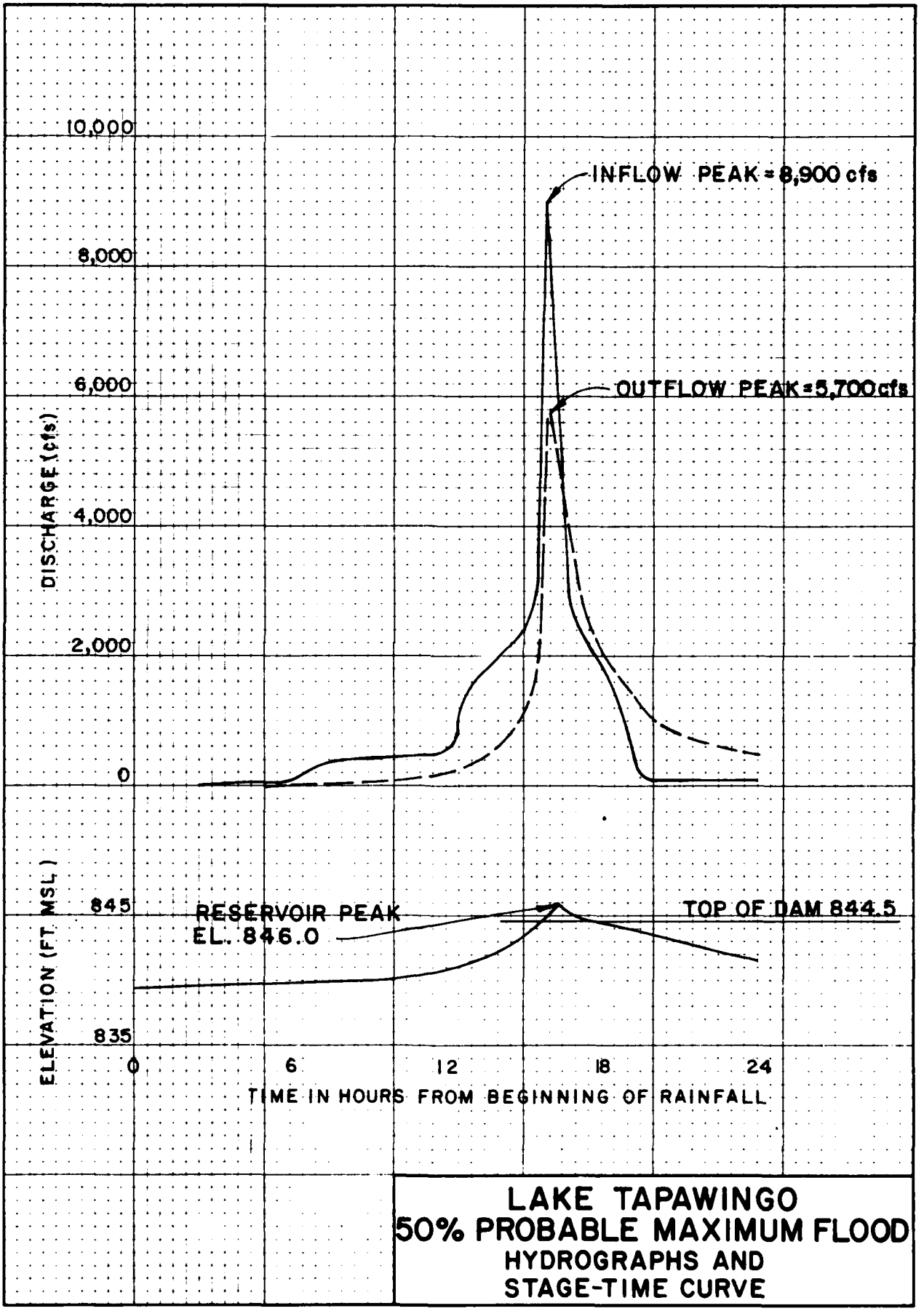
4. Floods are routed through the spillways using HEC-1, with the modified Puls routing method, to determine the capacity of the spillways. Inflow and outflow hydrographs are shown on Plates A-1, A-2, and A-3.

(1) U.S. Army Corps of Engineers, Hydrologic Engineering Center, Flood Hydrograph Package (HEC-1) Dam Safety Verson, July, 1978, Davis, California



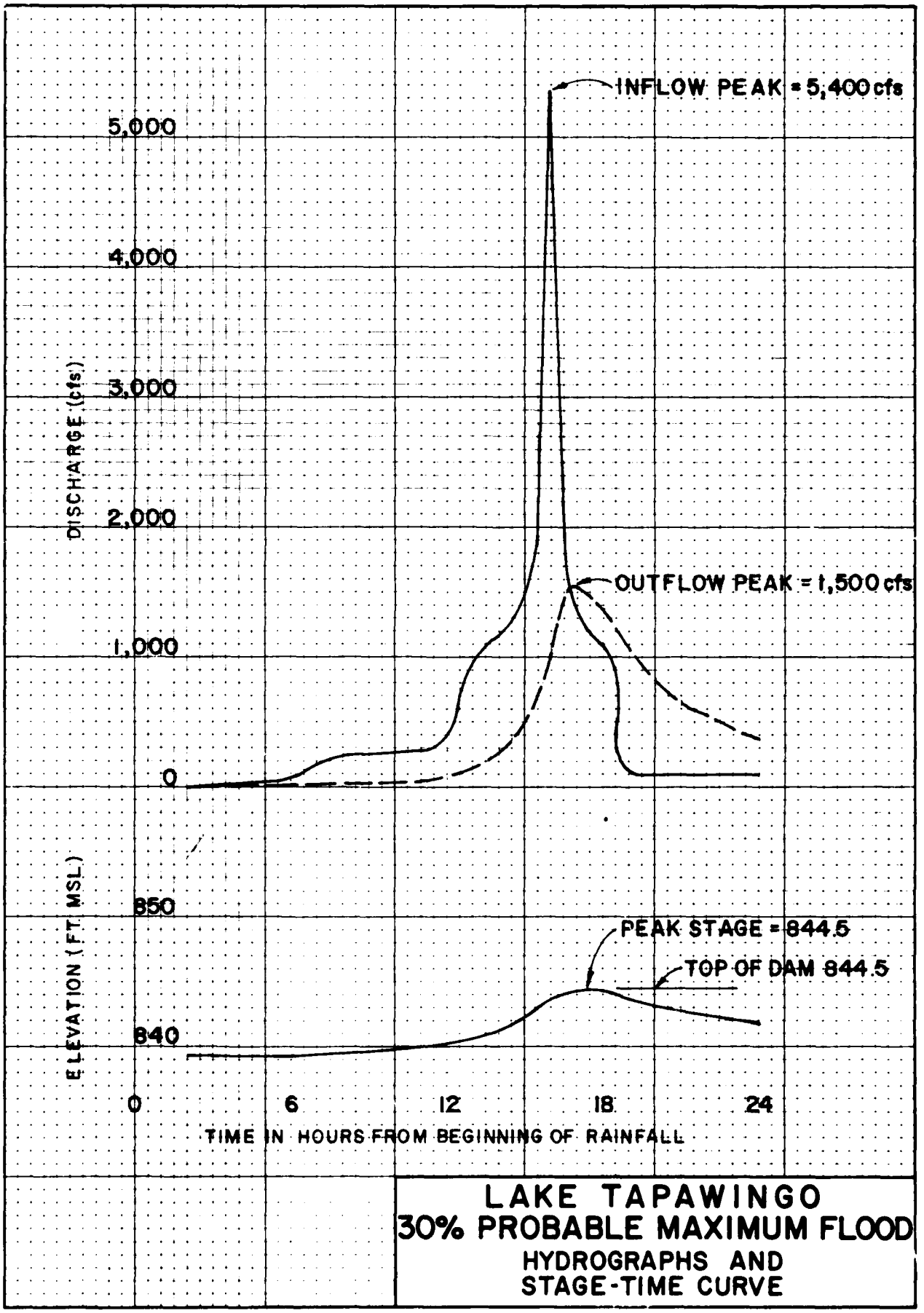
LAKE TAPAWINGO
PROBABLE MAXIMUM FLOOD
HYETOGRAPH, HYDROGRAPHS AND STAGE-TIME CURVE

PLATE A-1



LAKE TAPAWINGO
50% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS AND STAGE-TIME CURVE

PLATE A-2



LAKE TAPAWINGO
30% PROBABLE MAXIMUM FLOOD
HYDROGRAPHS AND STAGE-TIME CURVE

PLATE A-3


DATE:
TIME